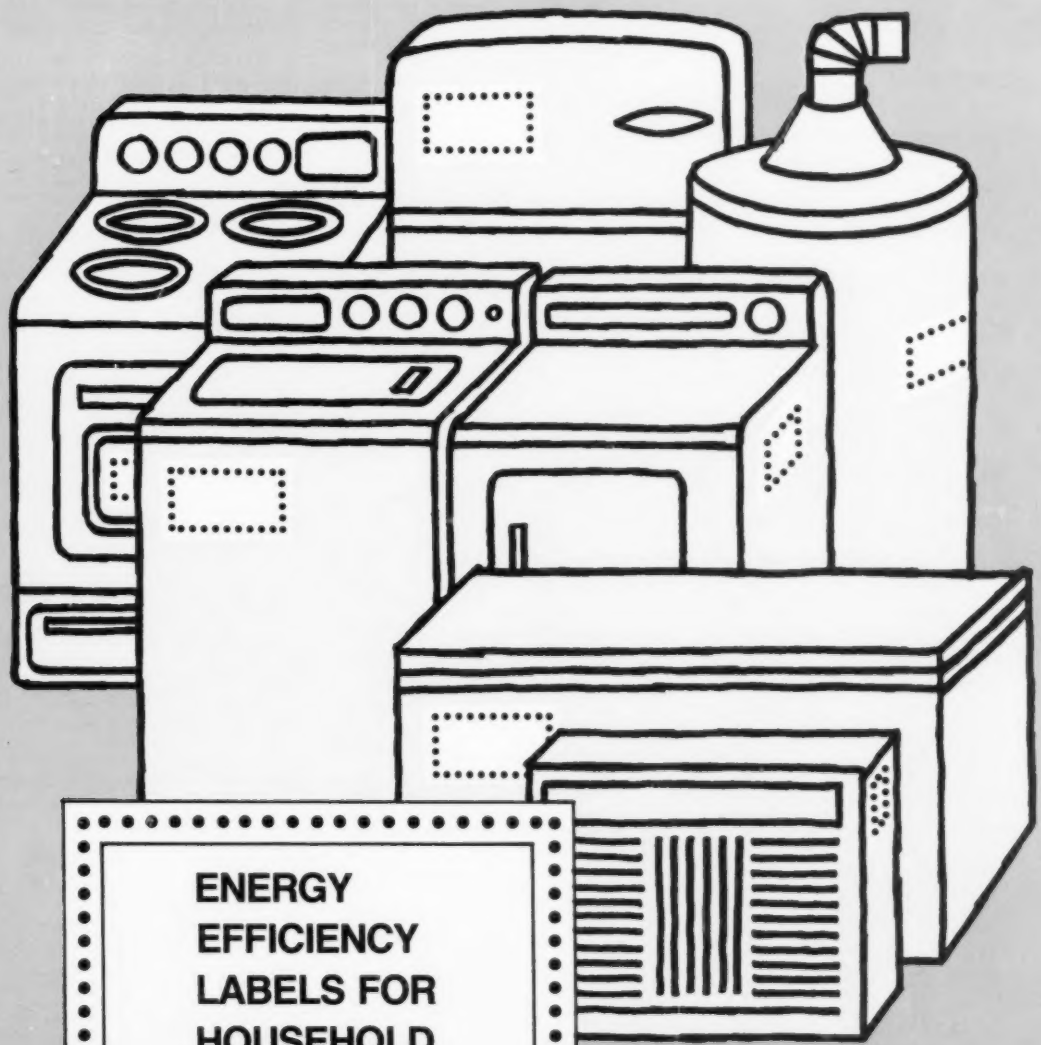
THE TECHNICAL NEWS BULLETIN OF THE NATIONAL BUREAU OF STANDARDS/ January 1974

DIMENSIONS/NBS



ENERGY EFFICIENCY LABELS FOR HOUSEHOLD APPLIANCES

A PUBLICATION OF THE UNITED STATES DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

DIMENSIONS/NBS

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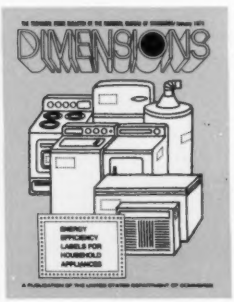

Cover: The system of voluntary energy-efficiency labels for home appliances being developed at NBS should help the consumer decide which appliance is most efficient and most desirable for his needs. See article on page 9.

U.S. DEPARTMENT OF COMMERCE
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The Institute for Basic Standards
The Institute for Materials Research
The Institute for Applied Technology
The Institute for Computer Sciences and Technology
Center for Radiation Research
Center for Building Technology
Center for Consumer Product Safety

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Quantity	Symbol	Value †	Uncert. (ppm)	SI ← Units →	cgs*
Ratio of muon and proton magnetic moments	μ_μ/μ_p	3.1833402(72)	2.3		
Muon magnetic moment	μ_μ	4.490474(18)	3.9	10^{-26} J·T^{-1}	10^{-23} erg·G^{-1}
Ratio of muon mass to electron mass	m_μ/m_e	206.76865(47)	2.3		
Muon rest mass	m_μ	1.883566(11)	5.6	10^{-28} kg	10^{-25} g
		0.11342920(26)	2.3	u	u
Compton wavelength of the electron, $h/m_ec=\alpha^2/2R_\infty$	λ_C	2.4263089(40)	1.6	10^{-12} m	10^{-10} cm
	$\lambda\!\!\!^{-}_C=\lambda_C/2\pi=\alpha a_o$	3.8615905(64)	1.6	10^{-13} m	10^{-11} cm
Compton wavelength of the proton, h/m_pc	$\lambda_{C,p}$	1.3214099(22)	1.7	10^{-15} m	10^{-13} cm
	$\lambda\!\!\!^{-}_{C,p}=\lambda_{C,p}/2\pi$	2.1030892(36)	1.7	10^{-16} m	10^{-14} cm
Compton wavelength of the neutron, h/m_nc	$\lambda_{C,n}$	1.3195909(22)	1.7	10^{-15} m	10^{-13} cm
	$\lambda\!\!\!^{-}_{C,n}=\lambda_{C,n}/2\pi$	2.1001941(35)	1.7	10^{-16} m	10^{-14} cm
Molar volume of ideal gas at s.t.p.	V_m	22.41383(70)	31	10^{-2} m^3·mol^{-1}	10^3 cm^3·mol^{-1}
Molar gas constant, p_oV_m/T_o ($T_o\equiv$273.15 K; $p_o\equiv$101325 Pa$\equiv$1atm)	R	8.31441(26)	31	J·mol^{-1}·K^{-1}	10^7 erg·mol^{-1}·K^{-1}
		8.20568(26)	31	10^{-5} m^3·atm·mol^{-1}·K^{-1}	10 cm^3·atm·mol^{-1}·K^{-1}
Boltzmann constant, R/N_A	k	1.380662(44)	32	10^{-23} J·K^{-1}	10^{-16} erg·K^{-1}
Stefan-Boltzmann constant, $\pi^2k^4/60\hbar^3c^2$	σ	5.67032(71)	125	10^{-8} W·m^{-2}·K^{-4}	10^{-5} erg·s^{-1}·cm^{-2}·K^{-4}
First radiation constant, $2\pi hc^2$	c_1	3.741832(20)	5.4	10^{-16} W·m^2	10^{-5} erg·cm^2·s^{-1}
Second radiation constant, hc/k	c_2	1.438786(45)	31	10^{-2} m·K	cm·K
Gravitational constant	G	6.6720(41)	615	10^{-11} m^3·s^{-2}·kg^{-1}	10^{-8} cm^3·s^{-2}·g^{-1}
Ratio, kx-unit to ångström, $\Lambda=\lambda(\text{Å})/\lambda(\text{kxu})$; $\lambda(\text{CuK}\alpha_1)\equiv$1.537400 kxu	Λ	1.0020772(54)	5.3		
Ratio, Å* to ångström, $\Lambda^*=\lambda(\text{Å})/\lambda(\text{Å}^*)$; $\lambda(\text{WK}\alpha_1)\equiv$0.2090100 Å*	Λ^*	1.0000205(56)	5.6		

ENERGY CONVERSION FACTORS

Quantity	Value †	Units	Uncert. (ppm)
1 kg	5.609545(16)	10^{29} MeV	2.9
1 u	931.5016(26)	MeV	2.8
Electron mass	0.5110034(14)	MeV	2.8
Muon mass	105.65948(35)	MeV	3.3
Proton mass	938.2796(27)	MeV	2.8
Neutron mass	939.5731(27)	MeV	2.8
1 electron volt	1.6021892(46)	10^{-19} J	2.9
		10^{-12} erg	2.9
	2.4179696(63)	10^{14} Hz	2.6
	8.065479(21)	10^5 m^{-1}	2.6
		10^3 cm^{-1}	2.6
	1.160450(36)	10^4 K	31
Voltage-wavelength conversion	1.2398520(32)	10^{-6} eV·m	2.6
		10^{-4} eV·cm	2.6
Rydberg constant, R_∞	2.179907(12)	10^{-18} J	5.4
		10^{-11} erg	5.4
	13.605804(36)	eV	2.6
	3.28984200(25)	10^{15} Hz	0.075
	1.578885(49)	10^5 K	31
Bohr Magneton, μ_B	5.7883785(95)	10^{-5} eV·T^{-1}	1.6
	1.3996123(39)	10^{10} Hz·T^{-1}	2.8
	46.68604(13)	m^{-1}·T^{-1}	2.8
		10^{-2} cm^{-1}·T^{-1}	2.8
	0.671712(21)	K·T^{-1}	31
Nuclear magneton, μ_N	3.1524515(53)	10^{-8} eV·T^{-1}	1.7
	7.622532(22)	10^6 Hz·T^{-1}	2.8
	2.5426030(72)	10^{-2} m^{-1}·T^{-1}	2.8
		10^{-1} cm^{-1}·T^{-1}	2.8
	3.65826(12)	10^{-4} K·T^{-1}	31

† Note that the numbers in parentheses are the one standard-deviation uncertainties in the last digits of the quoted value computed on the basis of internal consistency, that the unified atomic mass scale $^{12}C\equiv12$ has been used throughout, that u=atomic mass unit, C=coulomb, F=farad, G=gauss, H=henry, Hz=hertz=cycles/s, J=joule, K=kelvin (degrees kelvin), Pa=pascal=N·m^{-2}, T=tesla (10^4 G), V=volt, Wb=weber=T·m^2, and W=watt. In cases where formulas for constants are given (e.g., R_∞), the relations are written as the product of two factors. The second factor, in parentheses, is the expression to be used when all quantities are expressed in cgs units, with the electron charge in electrostatic units. The first factor, in brackets, is to be included only if all quantities are expressed in SI units. We remind the reader that with the exception of the auxiliary constants which have been taken to be exact, the uncertainties of these constants are correlated, and therefore the general law of error propagation must be used in calculating additional quantities requiring two or more of these constants.

* In order to avoid separate columns for "electromagnetic" and "electrostatic" units, both are given under the single heading "cgs Units." When using these units, the elementary charge e in the second column should be understood to be replaced by e_m or e_e, respectively.

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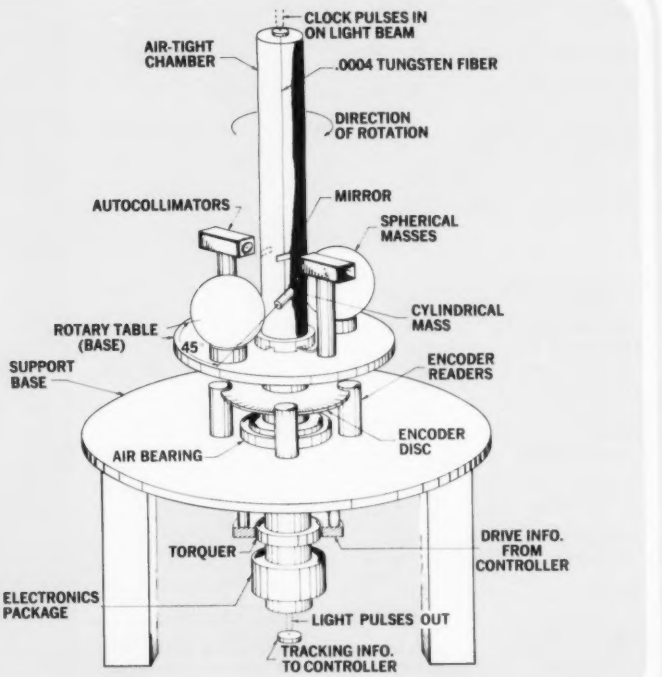
Group on Fundamental Constants of the Committee on Data for Science and Technology (CODATA), International Council of Scientific Unions. The Task Group, a panel of distinguished international experts, served in an advisory capacity. Financial support for the projects was shared among Rockwell International, the NBS Institute for Basic Standards and the NBS Office of Standard Reference Data.



The least accurately known constant is big G, the universal Newtonian gravitational constant. The drawing shows novel apparatus being used in an NBS-University of Virginia attempt to obtain a more accurate value.

The new recommended values of the constants and their estimated uncertainties have been officially adopted as a consistent set of fundamental constants based on "a new analysis of all the presently available information" by the Committee on Data for Science and Technology of the International Council of Scientific Unions.

Among the constants, one recognizes such old workhorses of scientific calculation as the speed of light, the constant of gravitation ("big G"), the ideal gas constant, the Faraday constant and the Avogadro constant, concepts already well-known before the 20th century science explosion. The great majority of the quantities listed, however, reflect the dominance of quantum theory and experimental nuclear and atomic physics: the Planck, Rydberg, and radiation constants, the Bohr radius (characteristic dimension of the hydrogen atom), the elementary electric charge and other properties—magnetic moments, masses, Compton wavelengths—of electrons, protons, neutrons, and muons, and the fine-structure constant, among others. Accurate (parts-per-million) values for some of these have only become attainable in the last few years.

Working Numbers

The permeation of the fundamental constants into all branches of physical science and their practical applications is, of course, no accidental spinoff of scientific activity, but the natural result of the effort to find out how things actually are. Fundamental constants are indispensable, in fact, wherever basic theories are applied to the real world. Usually unobtrusive, because used indirectly, the constants are turning up more often and more explicitly as increasingly wider areas of application fall under the sway of theory.

Radar devices for distance measurement and navigation, for example, make direct use of the speed of light. With the more accurate new value of this constant, as noted above, one should be able to measure the quarter-of-a-million-mile distance to the moon with an error no greater than about 15 cm (6 inches).

Similarly, the gas constant must be at hand in chemical laboratories and processing plants or wherever there is quantitative monitoring of gases. And the gravitational constant enters into calculations by earth scientists of the mass, mean density and mass distribution of the earth.

Often, especially in research where atomic and nuclear constants play a part, there is a fascinating mixture of pure science and technological potential. Thus, the calculation from basic theory of the electronic structures of certain crystals contributes to (1) the explanation of elastic and other properties of the substances and (2) the design of solid-state electronic devices and lasers. Indeed, the whole active frontier of quantum electronics is a rich field for employment of the constants.

For a final example, every study of a basic energy source, whether chemical or nuclear, is another instance in which constants aid both our un-

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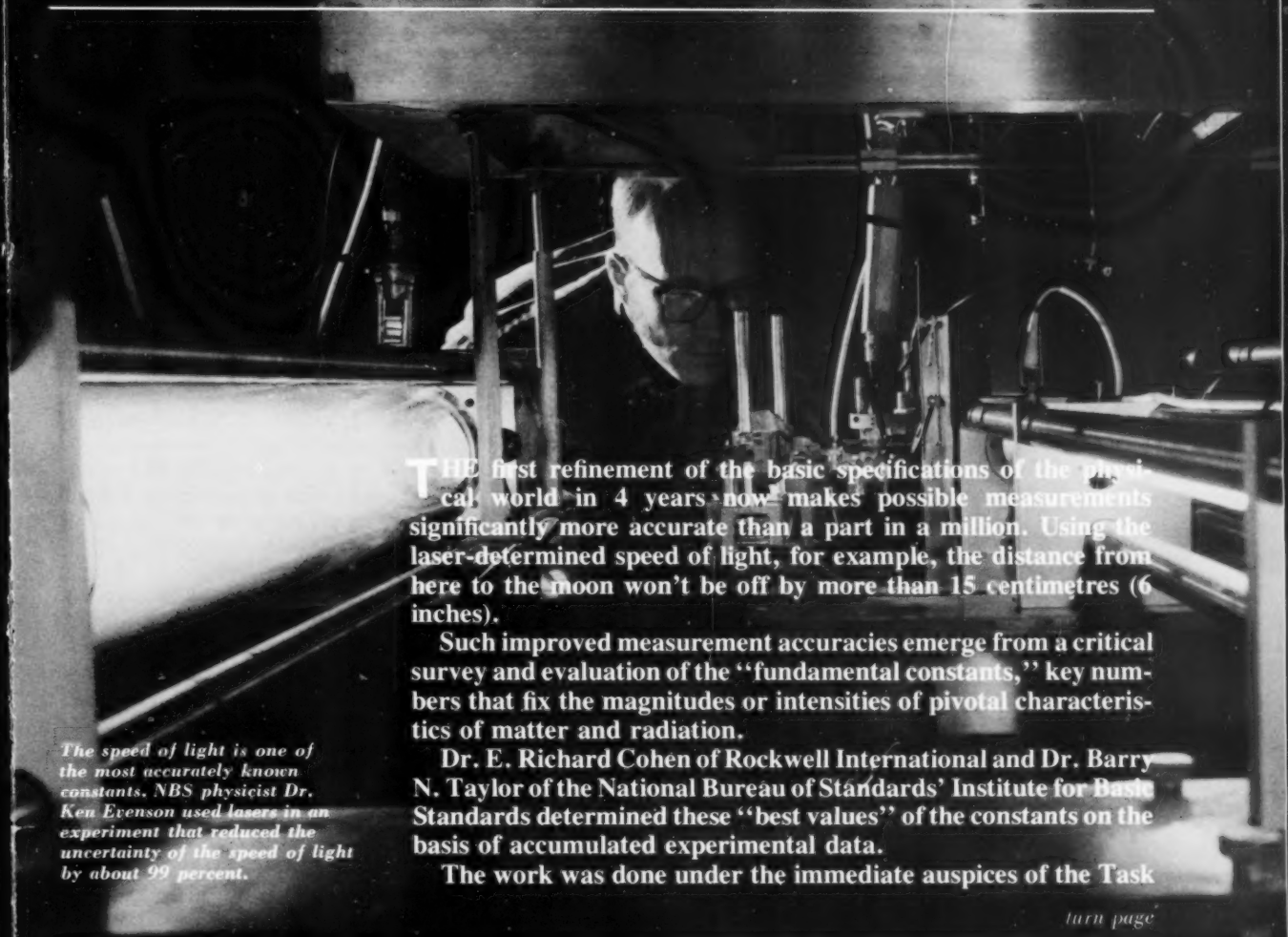
Specifications of the Physical World:



The speed of light is one of the most accurately known constants. NBS physicist Dr. Ken Evenson used lasers in an experiment that reduced the uncertainty of the speed of light by about 99 percent.

THE first refinement of the basic specifications of the physical world in 4 years now makes possible measurements significantly more accurate than a part in a million. Using the laser-determined speed of light, for example, the distance from here to the moon won't be off by more than 15 centimetres (6 inches).

Such improved measurement accuracies emerge from a critical survey and evaluation of the "fundamental constants," key numbers that fix the magnitudes or intensities of pivotal characteristics of matter and radiation.

Dr. E. Richard Cohen of Rockwell International and Dr. Barry N. Taylor of the National Bureau of Standards' Institute for Basic Standards determined these "best values" of the constants on the basis of accumulated experimental data.

The work was done under the immediate auspices of the Task

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New Values for the Fundamental Constants

FUNDAMENTAL CONSTANTS

Compiled by E. R. Cohen and B. N. Taylor under the auspices of the CODATA Task Group on Fundamental Constants. This set has been officially adopted by CODATA and is reprinted from J. Phys. Chem. Ref. Data, vol. 2, no. 4, p. 741 (1973) and CODATA Bulletin no. 11 (December 1973).

Quantity	Symbol	Value †	Uncert. (ppm)	SI ← Units →	cgs*
Speed of light in vacuum	c	299792458(1.2)	0.004	$m \cdot s^{-1}$	10^2 $cm \cdot s^{-1}$
Permeability of vacuum	μ_o	4π		10^{-7} $H \cdot m^{-1}$	
		$=12.5663706144$		10^{-7} $H \cdot m^{-1}$	
Permittivity of vacuum, $1/\mu_o c^2$	ϵ_o	8.854187818(71)	0.008	10^{-12} $F \cdot m^{-1}$	
Fine-structure constant, $[\mu_o c^2/4\pi](e^2/\hbar c)$	α	7.2973506(60)	0.82	10^{-3}	10^{-3}
	α^{-1}	137.03604(11)	0.82		
Elementary charge	e	1.6021892(46)	2.9	10^{-19} C	10^{-20} emu
		4.803242(14)	2.9		10^{-10} esu
Planck constant	h	6.626176(36)	5.4	10^{-34} J·s	10^{-27} erg·s
	$\hbar = h/2\pi$	1.0545887(57)	5.4	10^{-34} J·s	10^{-27} erg·s
Avogadro constant	N_A	6.022045(31)	5.1	10^{23} mol^{-1}	10^{23} mol^{-1}
Atomic mass unit, $10^{-3} kg \cdot mol^{-1} N_A^{-1}$	u	1.6605655(86)	5.1	10^{-27} kg	10^{-24} g
Electron rest mass	m_e	9.109534(47)	5.1	10^{-31} kg	10^{-28} g
		5.4858026(21)	0.38	10^{-4} u	10^{-4} u
Proton rest mass	m_p	1.6726485(86)	5.1	10^{-27} kg	10^{-24} g
		1.007276470(11)	0.011	u	u
Ratio of proton mass to electron mass	m_p/m_e	1836.15152(70)	0.38		
Neutron rest mass	m_n	1.6749543(86)	5.1	10^{-27} kg	10^{-24} g
		1.008665012(37)	0.037	u	u
Electron charge to mass ratio	e/m_e	1.7588047(49)	2.8	10^{11} $C \cdot kg^{-1}$	10^7 $emu \cdot g^{-1}$
		5.272764(15)	2.8		10^{17} $esu \cdot g^{-1}$
Magnetic flux quantum, $[c]^{-1}(hc/2e)$	Φ_o	2.0678506(54)	2.6	10^{-15} Wb	10^{-7} $G \cdot cm^2$
	h/e	4.135701(11)	2.6	10^{-15} $J \cdot s \cdot C^{-1}$	10^{-7} $erg \cdot s \cdot emu^{-1}$
		1.3795215(36)	2.6		10^{-17} $erg \cdot s \cdot esu^{-1}$
Josephson frequency-voltage ratio	2e/h	4.835939(13)	2.6	10^{14} $Hz \cdot V^{-1}$	
Quantum of circulation	$h/2m_e$	3.6369455(60)	1.6	10^{-4} $J \cdot s \cdot kg^{-1}$	$erg \cdot s \cdot g^{-1}$
	h/m_e	7.273891(12)	1.6	10^{-4} $J \cdot s \cdot kg^{-1}$	$erg \cdot s \cdot g^{-1}$
Faraday constant, $N_A e$	F	9.648456(27)	2.8	10^4 $C \cdot mol^{-1}$	10^3 $emu \cdot mol^{-1}$
		2.8925342(82)	2.8		10^{14} $esu \cdot mol^{-1}$
Rydberg constant, $[\mu_o c^2/4\pi]^2(m_e e^4/4\pi\hbar^3 c)$	R_∞	1.097373177(83)	0.075	10^7 m^{-1}	10^5 cm^{-1}
Bohr radius, $[\mu_o c^2/4\pi]^{-1}(\hbar^2/m_e e^2) = \alpha/4\pi R_\infty$	a_o	5.2917706(44)	0.82	10^{-11} m	10^{-9} cm
Classical electron radius, $[\mu_o c^2/4\pi](e^2/m_e c^2) = \alpha^3/4\pi R_\infty$	$r_e = \alpha\lambda\!\!\!^{-}_C$	2.8179380(70)	2.5	10^{-15} m	10^{-13} cm
Thomson cross section, $(8/3)\pi r_e^2$	σ_e	0.6652448(33)	4.9‡	10^{-28} m^2	10^{-24} cm^2
Free electron g-factor, or electron magnetic moment in Bohr magnetons	$g_e/2 = \mu_e/\mu_B$	1.0011596567(35)	0.0035		
Free muon g-factor, or muon magnetic moment in units of $[c](e\hbar/2m_\mu c)$	$g_\mu/2$	1.00116616(31)	0.31		
Bohr magneton, $[c](e\hbar/2m_e c)$	μ_B	9.274078(36)	3.9	10^{-24} $J \cdot T^{-1}$	10^{-21} $erg \cdot G^{-1}$
Electron magnetic moment	μ_e	9.284832(36)	3.9	10^{-24} $J \cdot T^{-1}$	10^{-21} $erg \cdot G^{-1}$
Gyromagnetic ratio of protons in H_2O	γ'_p	2.6751301(75)	2.8	10^8 $s^{-1} \cdot T^{-1}$	10^4 $s^{-1} \cdot G^{-1}$
	$\gamma'_p/2\pi$	4.257602(12)	2.8	10^7 $Hz \cdot T^{-1}$	10^3 $Hz \cdot G^{-1}$
γ'_p corrected for diamagnetism of H_2O	γ_p	2.6751987(75)	2.8	10^8 $s^{-1} \cdot T^{-1}$	10^4 $s^{-1} \cdot G^{-1}$
	$\gamma_p/2\pi$	4.257711(12)	2.8	10^7 $Hz \cdot T^{-1}$	10^3 $Hz \cdot G^{-1}$
Magnetic moment of protons in H_2O in Bohr magnetons	μ'_p/μ_B	1.52099322(10)	0.066	10^{-3}	10^{-3}
Proton magnetic moment in Bohr magnetons	μ_p/μ_B	1.521032209(16)	0.011	10^{-3}	10^{-3}
Ratio of electron and proton magnetic moments	μ_e/μ_p	658.2106880(66)	0.010		
Proton magnetic moment	μ_p	1.4106171(55)	3.9	10^{-26} $J \cdot T^{-1}$	10^{-23} $erg \cdot G^{-1}$
Magnetic moment of protons in H_2O in nuclear magnetons	μ'_p/μ_N	2.7927740(11)	0.38		
μ'_p/μ_N corrected for diamagnetism of H_2O	μ_p/μ_N	2.7928456(11)	0.38		
Nuclear magneton, $[c](e\hbar/2m_p c)$	μ_N	5.050824(20)	3.9	10^{-27} $J \cdot T^{-1}$	10^{-24} $erg \cdot G^{-1}$

CATALYSIS FOR CLEAN AIR

NITRIC oxide, a colorless poisonous gas produced in combustion processes, has setback America's progress toward air quality. Federal and State air pollution regulations have been delayed because of difficulties in developing and standardizing catalytic converters for automobiles capable of reducing nitric oxide (NO).

National Bureau of Standards research chemists are hard at work examining the fundamental processes of the decomposition of NO on the surface of metallic ruthenium, one of the catalysts being considered for the converters under development. The process breaks nitric oxide into nitrogen and oxygen. The problem is to come up with an efficient chemical process to handle large amounts of the pollutant.

The work at NBS is being done in the Surface Chemistry Section of the Institute for Materials Research under the direction of Dr. Ralph Klein.

The surface chemistry researchers investigate clean, well-characterized metal surfaces under high-vacuum conditions to avoid surface contamination. One technique used in this work of studying the decomposition of NO on surfaces is that of the very useful field emission microscope. The surface investigated was that of metallic ruthenium. In this method the surface, in the form of a tip of sharply pointed filament, is projected on a phosphor screen by electrons drawn from the tip by a strong electric field. This method enables Klein and his associates to make observations down to approximately 2 nanometers (0.08 millionths of an inch)—almost molecular detail.

The surface studies show that nitrogen is weakly adsorbed on the ruthenium, but oxygen is strongly adsorbed. Nitric oxide is strongly adsorbed and the inference with regard to its catalytic decomposition is that it is associated with weak ruthenium-nitrogen bonding and strong ruthenium-oxygen bonding.

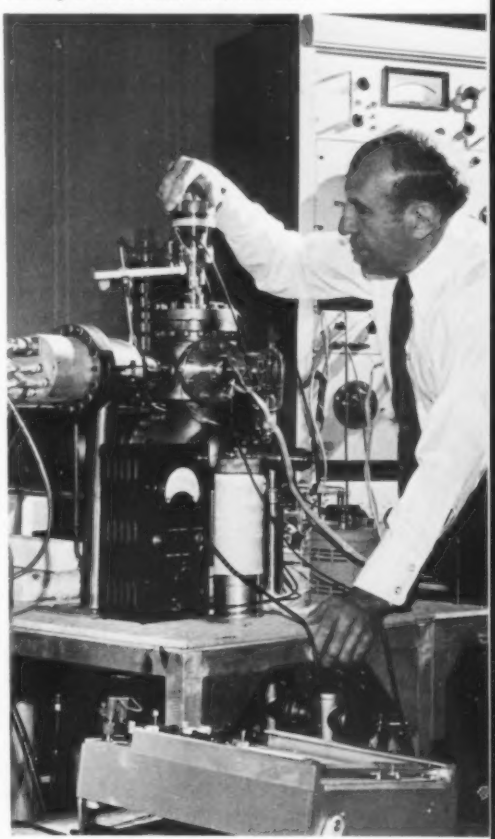
Once the nitric oxide has been adsorbed on the surface of the ruthenium and decomposed into nitrogen and oxygen, the NBS scientists are then concerned with freeing the nitrogen and oxygen into the atmosphere to allow for the further adsorption of NO to take place. In order to study the desorbing process qualitatively and quantitatively, experimental equipment has been constructed. Gases that are desorbed from the surface of the ruthenium are analyzed with a quadrupole mass spectrometer and the surface electrical potential is measured using an electron gun retarding potential method.

Several informative measurements have come from these investigations. For example, nitrogen, physically adsorbed at low temperature, is evolved completely at about 140K with only one weak binding state present. Nitric oxide is strongly adsorbed, and once adsorbed, it never comes off intact. This is, in fact, a catalytic process whereby nitric oxide is decomposed into its elements. Thus, when the nitric oxide covered surface is heated, nitrogen is desorbed in a complex manner but at a much lower temperature than is oxygen.

Further work is being done to understand this catalytic process through the use of x-ray photoelectron spectroscopy. In this technique x-rays focused on the sample cause the ejection of electrons from the atomic cores of the surface molecules. Adsorbed NO gives rise to O (1S) and N (1S) electrons. An energy analysis of these electrons show shifts in energy from that of the unperturbed free molecule. These energy shifts are a measure of the interaction of the molecule with the surface.

Klein indicated that studies like these should increase the efficiency of catalytic devices so pollution levels can be reduced to be consistent with the health and well-being of the Nation. □

Dr. Ralph Klein of the Surface Chemistry Division adjusts equipment prior to making a nitric oxide determination.



Bureau Tackles Energy Problem

The following is a statement by NBS Director Richard W. Roberts on NBS' contribution to energy conservation.

THE energy crisis is real. Nothing we do as a nation will allow us to use energy this winter at the rate we did a year ago. The question isn't whether there will be an energy shortage, but rather how we can use our limited resources with the least discomfort and disruption of our daily lives.

This Nation must achieve energy self-sufficiency, but that day is some years away. Such promising developments as coal gasification and breeder reactors, to which NBS is already contributing needed data, require substantial research and development before they will be major energy sources. In the meantime, the answer lies in energy conservation. The effects of shortages can be minimized greatly through wise use of those fuels we do have. And in this area NBS is in a leadership position.

First, let's look at what is being done within NBS. The President has already ordered a 7 percent reduction in Federal use of energy, a quota that may well be increased in the near future. NBS has taken steps to meet this reduction: room temperatures have been dropped to 20 °C (68 °F); one-third of the fluorescent lights have been removed; official travel has been reduced and many shuttle-bus runs have been eliminated. Of course there are many other energy saving actions that are being implemented, and still others are being considered.

To coordinate the NBS energy conservation efforts, a special Energy Task Force has been appointed. The activities of the Task Force will have a broad scope, including the formulation of plans under which the Bureau can respond to shortages of varying severity. Dr. John D. Hoffman, Director of the Institute for Materials Research, is providing full-time leadership of the Task Force, which is composed of others from the Bureau's technical and administrative staff.

Dr. Hoffman says that the physical well-being of the staff is paramount, and such actions as reduction of lighting levels and the lowering of room temperatures will not be done capriciously or at the expense of safety. And, of course, the physical plant must not be allowed to deteriorate.

The NBS campus at Gaithersburg is in effect a "mini-city" of 25 buildings, 100,000 m^2 of working area, 13 kilometers of corridors, and over 3,000 people. This complex will be treated as a demonstration project with respect to energy conservation, with a systems approach being taken to energy use and conservation. The results of this effort will be available for application to other facilities, large and small.

NBS expertise in the building area has already been directed to energy conservation. Two booklets, *7 Ways*[1] and *11 Ways*[2] were prepared several years ago, and a combined total of over 750,000 copies have been distributed to householders. □

[1] 7 Ways to Reduce Fuel Consumption in Household Heating . . . through energy conservation for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, as stock number 0303-0186 for 35 cents.

[2] 11 Ways to Reduce Energy Consumption and Increase Comfort in Household Cooling for sale by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, as stock number 0303-0876 for 30 cents.

AIR CONDITIONERS WILL BE ENERGY LABELED FIRST

UNDER the Department of Commerce's voluntary energy labeling program, the National Bureau of Standards has prepared proposed specifications for room air conditioners and is working on specifications for refrigerators, refrigerator-freezers, freezers and water heaters. The specifications include, as outlined in the October 26 *Federal Register:*

(1) A description of the class of appliance or equipment covered by the specification, listing the distribution of energy efficiencies for that class of appliance or equipment.

(2) Listings or descriptions of test methods to be used in measuring the energy consumption and/or energy efficiency characteristics of the class of appliance or equipment.

(3) A prototype label and directions for displaying the label on or with appliances or equipment of that class. The label shall . . . include information that will assist the consumer in comparing by cost or otherwise the energy consumption and/or energy efficiency characteristics of a particular appliance or item of equipment with all others in its class . . .

(4) Conditions for the participation of manufacturers in the program.

Comments on the proposed specifications will be reviewed, and a final procedure for labeling room air conditioners will be published in the *Federal Register*. A target date of August 1974 has been set for completing a proposal on refrigerators and refrigerator-freezers. NBS plans to cover specifications for freezers and water heaters by March of 1975.

This voluntary labeling program is aimed at effecting energy conservation by making the buyer aware of how much energy appliances consume and how much that consumption costs. It should also motivate manufacturers to become more energy conscious when designing products.

A more complete discussion of this program appeared in the August 1973 issue of *DIMENSIONS/NBS*. □

ENERGY CONSUMPTION AND OPERATING COSTS OF POPULAR HOUSEHOLD APPLIANCES

Appliance	*Est. Annual kWh	**Est. Annual Cost at 3¢ per kWh
Water Heater	5400	$162.00
Food Freezer (frostless)	1760	52.80
Food Freezer	1560	46.80
Refrigerator-Freezer (frostless) 14 cu. ft.	1505	45.15
Refrigerator-Freezer 14 cu. ft.	1330	39.90
Air Conditioner (window)	1265	37.65
Range	1225	36.75
Clothes Dryer	1100	33.00
Refrigerator-Freezer 10 cu. ft.	1085	32.55
Refrigerator	460	13.80
Television (color)	450	13.50
Dehumidifier	380	11.40
Television	345	10.35
Dishwasher	340	10.20
Fan (attic)	310	9.30
Frying Pan	190	5.70
Fan (Window)	145	4.35
Blanket	140	4.20
Iron (hand)	135	4.05
Coffee Maker	95	2.85
Radio	90	2.70
Washing Machine (automatic)	65	1.95
Vacuum Cleaner	40	1.20
Toaster	35	1.05
Clock	18	.54
Heating Pad	9	.27
Hair Dryer	7	.21
Shaver	2	.06

* Figures compiled by the Potomac Electric Power Company.
** 3¢/kWh (kilowatt-hour) used for convenience, rates may vary depending upon location and type of dwelling.

HIGHLIGHTS

Pipeline Impact Study

NBS is developing measurement techniques for use in a collaborative effort with the National Oceanic and Atmospheric Administration to determine the part-per-billion levels of crude oils in Alaskan marine organisms and sediments. Prince William Sound, Valdez, Alaska, is the site of the studies, which are targeted for completion prior to the construction of the proposed Alaskan pipeline. Because the marine environment in Alaska is pristine (the only significant source of oil contamination to date was the earthquake of 1964), the program affords a unique opportunity to characterize changes in the ecological system during a period of development.

Safeguarding Nuclear Material

Fissionable materials that fuel nuclear reactors must be carefully accounted for. Since the mid 1960's NBS has been working for the Arms Control and Disarmament Agency, the Atomic Energy Commission and the International Atomic Energy Agency to develop more effective methods of monitoring these materials wherever they are used or stored.

The Bureau has combined television and lapse-time photography to produce a device that can better safeguard our nuclear fuels. This device can make photographs on demand when one or more points in the field of view are altered or obscured.

Mapping Oxygen in Brain Tissue

In a cooperative program with the Weizmann Institute of Science, Rehovot, Israel, the Bureau is studying the oxygen distribution in brain tissues. Using brains from rats that have breathed oxygen ^{17} enriched air, Bureau scientists are employing the nuclear track technique to locate those areas of the brain in which molecular oxygen is exchanged from the respiratory systems. Knowledge of the distribution of oxygen in brain tissues will be useful to those in the field of neuromedicine in detecting brain damage and developing corrective measures for it.

EMI Testing Techniques

NBS has developed a new method for testing the susceptibility to electromagnetic interference (EMI) of electronic equipment and components and for calibrating EMI hazard meters and field-strength meters. In a recent application of this technique some smoke-sensitive fire alarms, which might be used near government radio transmitters or radar beacons, were shown to need careful shielding in such high EMI areas to reduce the false-alarm rate.

Trace Analysis

Papers are solicited for the 7th Materials Research Symposium "Accuracy in Trace Analysis," to be held at NBS Gaithersburg on October 7-11, 1974. Over the past several years there has been an explosion in the number of chemical analyses performed, especially in the areas of environmental quality, plant and animal tissues, biological fluids, high-purity materials and geological samples. The symposium will explore the various factors that contribute to obtaining accurate analytical results.

For information contact Dr. Philip LaFleur, B108 Reactor Building, NBS, Washington, D.C. 20234. Telephone: 301/921-2613.

Energy Guidelines

At the request of the National Conference of States on Building Codes and Standards (NCSBCS), NBS is drafting an interim standard for energy conservation in building design. The proposed interim standard would make energy conservation a major concern in the design of building form, orientation, insulation, fenestration and mechanical and electrical systems.

Assisting the Bureau are representatives from NCSBCS, the American Institute of Architects, the American Society of Heating, Refrigerating, and Air Conditioning Engineers and the Consulting Engineers' Council. Draft guidelines are scheduled to be completed early this year.

Consumer Metric Booklet

A new consumer booklet giving the essentials of the metric system of measurement has been compiled at NBS. Titled "What About Metric," it is designed to give consumers the few terms and relationships they need

On hands and knees in Prince William Sound, Alaska, Dr. Stuart Cram of the NBS Analytical Chemistry Division takes a sediment sample to establish natural levels of crude oil hydrocarbons in the environment before pipeline construction begins.

to use the metric system and relate it to the system they have been accustomed to using. It also explains the reasons why the United States is increasing its metric usage and describes the impact of this action on both consumers and workers.

The booklet is largely two-color illustrations and diagrams with a minimum of text. It gives visual comparisons and simple illustrations for quick understanding.

"What About Metric" is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 80 cents. It is identified as NBS Consumer Information Series 7 and as GPO stock number 0303-01191.

Measuring Noise

NBS has devised prototype instrumentation to monitor environmental noise. The monitor is a self-contained, battery-operated unit that measures and records the time intervals over which an environmental noise level greater than one of six specified amounts existed.

As the Department of Housing and Urban Development has published noise-assessment guidelines that are used as site-screening tools, especially for publicly funded housing, this instrumentation should be useful in resolving appellate applications and clarifying questionable site classifications.

Platinum Resistance Thermometry

NBS recently published a comprehensive monograph on the calibration and application of platinum resistance thermometers (PRT's). The PRT is the standard, both nationally and internationally, for the determination of temperature from −259 to 631 °C (−434 to 1168 °F), the range most often encountered in practice. The PRT is used in defining the International Practical Temperature Scale of 1968. The limitations, possible sources of errors and precautions to be observed in the application of PRT's are included in the monograph.

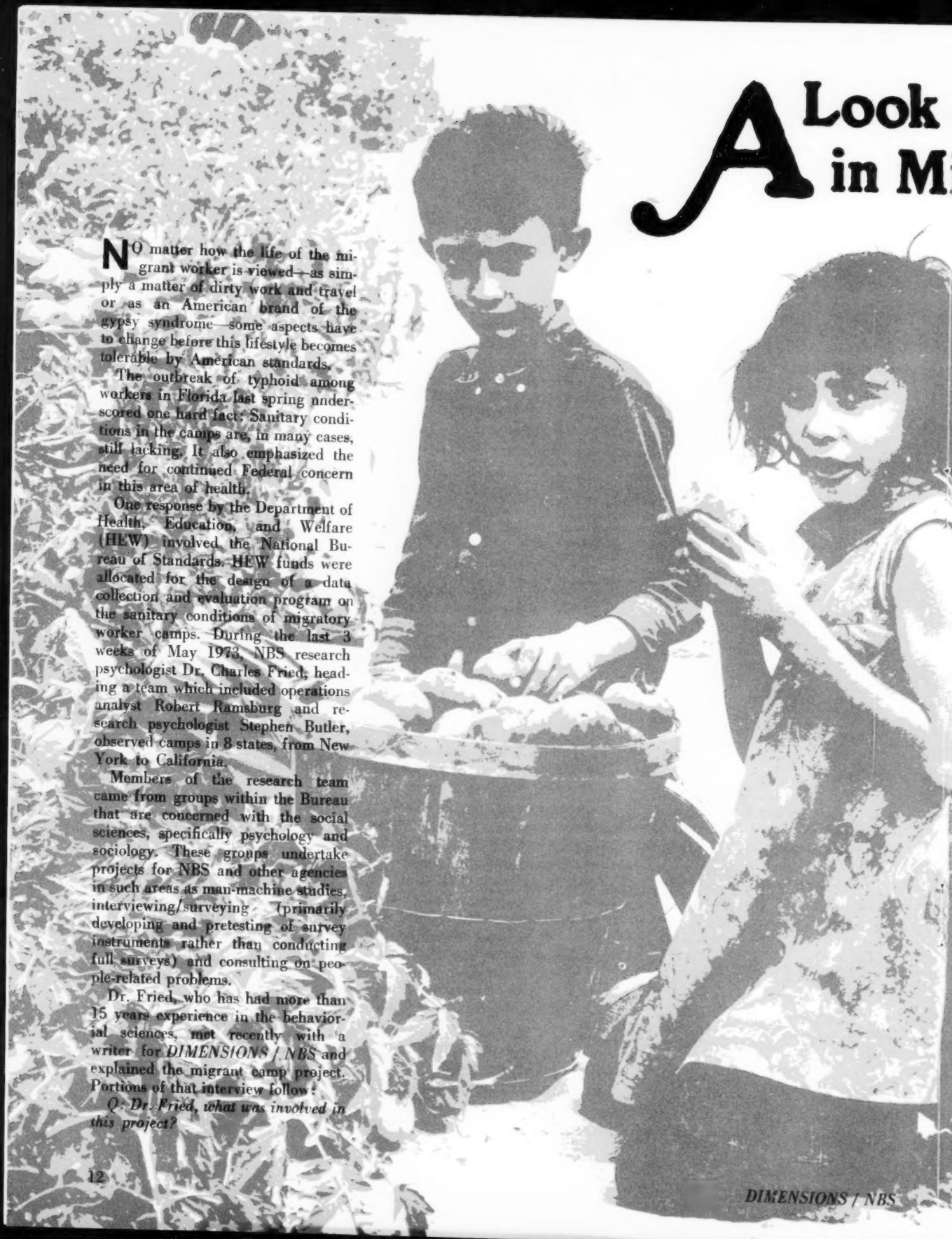
Titled "Platinum Resistance Thermometry," the monograph is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $2.10. It should be ordered as SD Catalog No. C13.44:126.

NBS-Japanese Symposium

NBS Boulder collaborated with organizations in Japan to develop the Joint Symposium on Microwave Measurements that was held on December 7 in Tokyo. Coinciding with the Commerce Department's Exhibition on Microwave Circuits, Components and Instrumentation at the U.S. Trade Center in Tokyo, the symposium dramatized the common interests of the electronics communities of both countries, which are among the most advanced in the world.

The exhibition and symposium were part of the Commerce Department's and NBS' continuing program to improve the U.S. balance of trade position and to assist U.S. industry in its overseas marketing effort. □

A Look in M



NO matter how the life of the migrant worker is viewed—as simply a matter of dirty work and travel or as an American brand of the gypsy syndrome—some aspects have to change before this lifestyle becomes tolerable by American standards.

The outbreak of typhoid among workers in Florida last spring underscored one hard fact: Sanitary conditions in the camps are, in many cases, still lacking. It also emphasized the need for continued Federal concern in this area of health.

One response by the Department of Health, Education, and Welfare (HEW) involved the National Bureau of Standards. HEW funds were allocated for the design of a data collection and evaluation program on the sanitary conditions of migratory worker camps. During the last 3 weeks of May 1973, NBS research psychologist Dr. Charles Fried, heading a team which included operations analyst Robert Ramsburg and research psychologist Stephen Butler, observed camps in 8 states, from New York to California.

Members of the research team came from groups within the Bureau that are concerned with the social sciences, specifically psychology and sociology. These groups undertake projects for NBS and other agencies in such areas as man-machine studies, interviewing/surveying (primarily developing and pretesting of survey instruments rather than conducting full surveys) and consulting on people-related problems.

Dr. Fried, who has had more than 15 years experience in the behavioral sciences, met recently with a writer for *DIMENSIONS / NBS* and explained the migrant camp project. Portions of that interview follow:

Q. Dr. Fried, what was involved in this project?

k at Sanitary Conditions Migrant Camps

A: HEW wanted two things: empirical data, instead of just random reports, on the sanitary conditions of camps and a method of getting additional data. NBS has the capability of doing investigations such as surveys for other agencies of government. I want to stress, however, that this was not a survey to evaluate the sanitary conditions of the camps. That kind of work is up to technical people like health officials responsible for seeing that governmental regulations are complied with. Our job was to develop a procedure for evaluating conditions that lay people can use to conduct in-depth surveys.

As the law now stands, ultimate responsibility for sanitary conditions of migrant labor camps rests with the owners, and responsibility for making sure that the owners meet regulations belongs to state and local governments. The Bureau of Community Health Services, a branch of HEW, is exploring ways to work with the states in dealing with the camps' sanitary conditions. The procedure NBS developed will be used by HEW and other groups to help in this work.

Q: How did you go about planning and carrying out your work?

A: First we took forms employed by sanitarians in such states as New York, Texas and California from which we developed our own questionnaire. These questionnaires indicated what we should look for. For instance, we checked things like the number of people sleeping in one room, the condition of sleeping quarters, availability of running water, and the presence of garbage and debris.

We then chose as many regions of the country as possible so that the survey would reflect living conditions over a wide area.

Q: How did you get admitted to the camps?

A: We simply asked permission to enter when we got there. Before we went to the camp, we contacted the appropriate state and local officials. In most cases a local sanitarian accompanied us to the camps, but the owners were not told we were coming.

Q: Did anybody deny you permission?

A: No. I don't know whether the owners were pleased with the idea of the survey, but we made clear that we were not checking for violations. The camps have been getting a number of visitors in the past few years, and the owners are probably getting used to it.

Q: Who chose the camps to be visited?

A: The sanitarians chose some, and we chose others at random. We analyzed the data separately to avoid giving only a view that was weighted by the sanitarians' preferences.

Q: What does the survey show about the conditions? What is the meaning of the results presented in your report?

A: There are statistics you can cite from the report to give some idea of some of the living conditions. Just remember that although the findings are interesting, we can't generalize about the conditions by looking at them because the main purpose of the "survey" was to develop and pre-test the survey instrument—the time was limited to a 3-week period in May, so we couldn't keep track of how sanitary conditions deteriorated. We probably saw the camps at their best since the season had just started and none of them were crowded. Furthermore, we can't generalize because of some technical reasons. For instance, the size of the sample was selected for pre-test purposes only.

Q: You mentioned that the survey has at least one drawback because of the 3-week time limit on the work. Do you intend to improve on what you've done by continuing in this area?

A: I have suggested to the Bureau of Community Health Services that we expand on the observations and also look at some different areas. For example, the matter of child care practices.

In answer to your question, I can't give a definite yes or no. We'll have to wait and see.

Survey Highlights

The most important part of the NBS report to HEW was the questionnaire designed to allow laymen to describe sanitary conditions. The results from the field test are based

turn page

The trend in migrant housing is toward motel-style buildings constructed of cinder blocks. (Photo courtesy of Department of Agriculture.)

on pre-test conditions and should not be considered as conclusive evidence of the sanitary conditions in migrant camps. However, these findings may be of interest to those concerned with the Bureau work, and they have been included here for that reason.

Older housing units are usually wood cabins. (Photo courtesy of Department of Agriculture.)

The researchers were looking into matters that relate to health as affected by sanitation in the camps. Many subjective judgments had to be made, and the possibility of personal bias has to be taken into consideration. Dr. Fried and his associates have made this point clear in the report itself and although subjectivity cannot be entirely eliminated, they have offered suggestions for reducing the number of subjective judgments in future studies.

HEW has released the survey observations for publication in *DIMENSIONS*. Although space doesn't permit recounting all the information gathered by the NBS team, a brief summary of the main sections of the survey can supply an overview. All facts that follow are based on the randomly selected camps, not those chosen by local sanitarians.

Water Supply

On the days of the researchers' visits, fresh water was not readily available to occupants in 1/5 of the camps. In 16 percent of the cases, the water supply was simply not working on the day of the visit.

Most state and federal regulations require an adequate and convenient supply of water. Standards for the quality of the water are established by the local health authority. However, in 22 percent of the cases, no water sample had been taken in the first 5 months of 1973. All of these camps were occupied, and the water was being used without assurance that it was safe.

Toilets and Privies

Eighty-five percent of the camps had flush toilets and 15 percent had privies. However, toilet facilities for migrants are far from ideal. Eighty percent of these facilities are shared. They are generally large washrooms in which the toilets, showers, lavoratories, urinals and occasionally laundry facilities are combined.

Toilets can be one of the major sources of communicable diseases in a migrant labor camp. Yet 26 percent of the facilities were either dirty or foul smelling. Poor maintenance and lack of enforcement of state and federal sanitary regulations by local health officials were the probable reasons for the condition of the toilets. The camp owner frequently blamed the migrant and held him responsible for cleaning the facilities. In some states, such as California, the camp manager is required to designate a laborer to clean the facilities. Nevertheless, the final responsibility for cleanliness of a shared toilet belongs to the owner.

Bathing Facilities

A migrant farm worker spends much of his working time, whether involved in sugar beet cultivation in the North or citrus fruit harvesting in the South and Southwest, in the fields exposed to dirt and pesticides. Yet in 28 percent of the camps, the migrant had to walk more than 30 meters (approximately 100 feet) to bathe. This is usually an outdoor walk to an unheated facility. It is uncommon for the owner to provide a changing room, and 20 percent of the time there were not even hooks to hang clothes on in the shower room. In 28 percent of the cases, water formed pools due to improper drainage on the shower room floor, and in 15 percent of the bathing facilities the floor was dirt rather than the cement or wood required by most state regulations.

Housing and Related Topics

The survey team reported that the housing was in good or average condition. There was no mention of un-

sound buildings in their reports. There were no dirt floors (except for bathing facilities) or leaking roofs. Nearly all the housing complied with the federal regulations requiring living units to be "so located as to prevent the entrance of ground and surface water." Also, electricity was available in all buildings.

Cabins are the most common form of unit and wood the principal construction material. There seems to be a trend in the newer camps towards the use of motel-style buildings constructed of cinder blocks.

In 49 percent of the camps no screen doors were provided, a potentially serious problem since open doors are often the major source of ventilation on hot days. Lack of screens and the presence of poorly fitted doors mean that migrants have no adequate protection against mosquitos and rodents. This is especially important in camps where poor garbage disposal promotes the breeding of disease-bearing insects and rodents.

Sewage and Garbage Disposal

As far as the researchers could determine, sewage disposal was not a health problem in any of the camps they visited.

On the other hand, garbage disposal was a hazard in a majority of the cases. Most camps had exposed garbage cans which can draw flies, mosquitoes and rats. Thirty-four percent of the units had central garbage facilities within 100 feet of a kitchen.

One Point of View

Stephen Butler, one of the NBS investigators, made an observation that gives an insider's perspective on the situation. After listening to some of the workers comment on the kind of life they lead, Butler said, "We have a tendency to think that the workers would all rather do something else. Some of the people I talked to like the kind of life they lead, the combination of seasonal work and mobility. But nobody enjoys the hardship of living in dirty and uncomfortable surroundings." □

Physical World *continued*

derstanding of the process and its practical utilization.

Improved Accuracy

The "1973 adjustment" of the fundamental constants is the outcome of a review and analysis of all the experimental and theoretical data that bear on determination of their numerical values. Experimental results and methods were carefully scrutinized and compared. In some cases, later improvements in theory or the detection of overlooked experimental bias revealed the presence of non-negligible errors; and appropriate corrections were worked out, often with the assistance of the original investigators. In the case of the speed of light, all older determinations were discarded in favor of the recent measurements using lasers, whose uncertainty is smaller by a factor of about 75. The analysis also took into account the uncertainties in the standards of measurement as maintained by various national laboratories.

What is required is a set of values that agree as closely as possible with the experimental results while conforming as closely as possible to the accepted theoretical relations connecting the constants with one another. An optimum solution, in a sense sanctioned by long experience with the habits and vagaries of experimental errors, is obtained by the "least squares" method, a complex computation that has been materially facilitated by electronic computers. The high-speed computers not only eliminate most of the drudgery, but also make it possible to perform numerical experiments that give greater insight into the way errors in one constant affect the values computed for others.

In recommending official adoption of Cohen and Taylor's 1973 adjustment of the constants, the CODATA Task Group noted that:

"The accuracy and consistency of this adjustment are significantly improved with respect to either the 1963 analysis or the 1969 analysis, yet there are critical areas where additional measurements and theoretical calculations are indicated. The most important of these are the proton gyromagnetic ratio (both high and low field measurements) and the fine structure in hydrogen . . ."

Identification of areas where further measurements and theory development are particularly needed is one of the important by-products of the analysis underlying the revision of the constants. Summing up, the Task Group states:

"For the great bulk of physical and chemical data, where consistency of usage and traceability are perhaps as important as accuracy (and with the recognition that absolute accuracy is a prize that will always elude our grasp), these values should serve as a standard reference set for the next several years." □

[1] FOR MORE INFORMATION: All quotations in the above article are from the report, dated 10 August 1973, of the CODATA Task Group on Fundamental Constants, whose members are: E. Richard Cohen (USA), R. D. Deslattes (USA), H. E. Duckworth (Canada), A. Horsfield (UK), B. A. Mamyrin (USSR), B. N. Oleinik (USSR), H. Preston-Thomas (Canada), U. Stille (Germany, Fed. Rep.), J. Terrien (France), and Y. Yamamoto (Japan). This report is being published in **CODATA Bulletin** No. 11 (Dec. 1973). Cohen and Taylor's report is being published in **J. Phys. Chem. Data,** Vol. 2, No. 4, 741 (1973). Measurement of the speed of light using a laser beam is described in NBS **Tech. News Bull.,** Jan. 1973, p. 15. The 1963 and 1969 analyses of the constants are respectively in: E. R. Cohen and J. W. M. DuMond, **Rev. Mod. Phys.** Vol. 37, 537 (1965); and B. N. Taylor, W. H. Parker and D. N. Langenberg, **Rev. Mod. Phys.** Vol. 41, 375 (1969).

When is a Hot Pot Hot?

THE American housewife may well be accustomed to withstanding the proverbial "heat in the kitchen." But how can she know, for sure, that she won't get burned when she hurries to the stove to lift the lid from that new pot she just bought? The knowledge of surface temperature is not sufficient to predict the relative safety or hazard of human contact with a heated object. For instance a metal surface is more likely to cause thermal injury than a plastic surface at the same temperature.

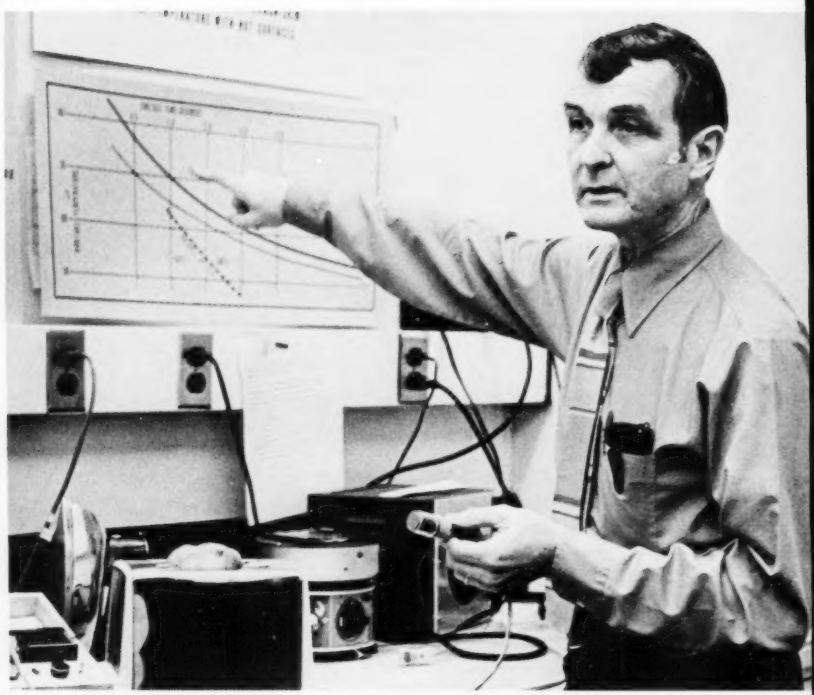
The potential for such injury is typical of the challenges confronting the Consumer Product Safety Commission as it seeks to establish and administer an increasing number of safety criteria and regulations. In this instance, an instrument has been developed by a National Bureau of Standards electronics engineer which can duplicate human-skin contact temperature with a heated surface.

The instrument is called a "thermesthesiometer" by Louis A. Marzetta, who developed the device under the sponsorship of the Food and Drug Administration, Bureau of Product Safety (now within the Consumer Product Safety Commission). Marzetta reports that the device is capable of qualitatively establishing the thermal hazard associated with any surface, without reference to the composition or material of the surface being tested.

Application

The instrument promises to satisfy requirements of designers for a method to evaluate the safety of products that involve generation of heat. The device can also provide government regulatory compliance with certain thermal safety regulations.

Practical advantages of the thermesthesiometer include its ease of operation, and the fact that values



Inventor Louis Marzetta demonstrates thermesthesiometer. Probe part of device senses heat as does the human finger, and rest of equipment registers the result.

obtained with the probe are traceable to the fundamental constants; hence, no individual calibration is needed. The instrument is light, compact and easily portable.

The Thermesthesiometer

The thermesthesiometer consists of a cylindrical measuring probe and an electronic unit that controls the timing of the measurement and provides a visual digital reading of the contact temperature in degrees Celsius or Farenheit. The end of the probe, likened to a human finger and designed to be pressed against the heated surfaces to be tested, is made of a silicone rubber. This material is resilient, as is human tissue, and it displays thermal properties close to that of human tissue. A heater wire is wound around the inner core tube, and a resistance thermometer transducer is positioned along the central axis of the core tube. This assembly terminates in a measuring thermocouple that serves as a contact temperature sensor, located just below the surface of the end of the probe. These components form the basis of a temperature controlling circuit that maintains the probe assembly at 33 °C—the temperature of human finger tissue. The subsurface location of the measuring thermocouple is at a depth equivalent to the dermal layer containing the nerve in human skin.

Reaction

Original research on heat-flow characteristics of materials and an examination of the medical literature by Dr. Yung-Chi Wu, an NBS investigator, indicates that damage to tissues from heated surfaces is a function of the heat transferred to human tissue from the material and the length of time the tissue is in contact with the surface. Also, physiologists have observed that, for most persons, a period of one second will elapse between the point of touching a heated surface and the experience of pain and reaction to pain. This phenomenon is due to the fact that about one second is required for the pain "message," received in the tactile nerve endings of the skin, to reach the brain and for reaction to take place.

Skin Damage

Thermal damage to the skin actually occurs at the interface between the epidermal, or outer layer of the skin, and the dermis. In the average person, this layer is located about 80 micrometers below the outer skin surface. As previously noted, the measuring thermocouple in the probe is located just beneath the probe's end, thus it is positioned to measure temperatures that would normally be experienced at the dermal layer of a human finger, where burning actually occurs. Experimentation has shown that thermal injury for dermal temperatures between 50 °C and 72 °C is due to the thermal inactivation of tissue elements, and above 72 degrees the destruction mechanism is attributed to protein coagulation.

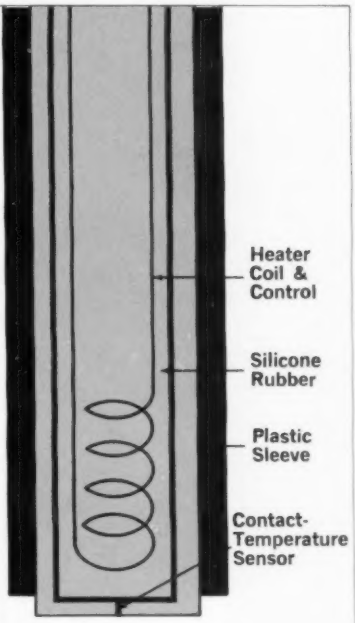


Diagram of heat-sensing portion of thermesthesiometer.

Hazardous Materials

Marzetta points out that the most hazardous materials, from a thermal standpoint, are those with heat flow characteristics that allow human tissues in contact with them to attain temperatures of about 65 °C in one second. Materials with heat flow characteristics that would allow tissue to attain 55 °C, but only after more than one second, are less hazardous. This assumes that someone exposed to such a surface would react in pain and withdraw from it before sustaining a burn or blister. Other materials that will not transfer heat sufficient to raise human tissues to 50 °C, even over considerable time, might be considered "safe," though the threshold of pain is about 45 °C.

Capabilities

The thermesthesiometer is capable of indicating the temperature that would be experienced if human contact were made to the heated surface in question. A circuit timing control to allow measurements to be made can be set for contact periods at increments of 1, 2, 4, or 8 seconds. Measuring time is automatically actuated upon thermal contact between the probe and the hot surface; at the end of the selected period the last contact temperature reading is "frozen" at the digital panel indicator until released by a manual reset feature. □

TAKING THE DRUNK DRIVER'S MEASURE

Today, with over 30,000 traffic deaths a year attributed to drunkenness the problem has become a grim one.

THE driver is able to sit up, able to grasp the wheel, able to depress the accelerator—but he's "had a few." Is he drunk or sober?

In more innocent times—before the automobile—the line between drunkenness and sobriety was simply drawn:

Not drunk is he who from the floor
Can rise alone and still drink more;
But drunk is he who prostrate lies,
Without the power to drink or rise.

Folklore's horizontal-or-vertical test for the condition is being superseded by science's precise measurements of blood or breath alcohol concentrations.

Work is now being done at the National Bureau of Standards to develop performance standards for five different types of breath-tester devices. This project is being managed at NBS by the Law Enforcement Standards Laboratory (LESL) under an interagency agreement with the Department of Transportation's National Highway Traffic Safety Administration (NHTSA).

The first standard—for "evidential breath testers"—was published in the November 5th *Federal Register.* Breath testers meeting the standard will be placed on NHTSA's qualified product list, and Federal funds used by police to purchase these devices under the Highway Safety Act will be expended only for listed devices. Aim of the program is to provide reliable standards for the five basic breath-testing devices being used to determine a suspect's alcohol content.

Need for Standards

All 50 states have "implied consent" laws. The state's willingness to grant a driver's license must be matched by the applicant's willingness to accept the condition that he will, as a licensed driver, submit to chemical tests (of blood, breath, or urine) when requested by police. Presumably, implied consent carries with it know-how on the part of law enforcement authorities to make positive identification of drunk drivers by scientific means.

Police and prosecutors, confronted with an increasing array of breath-testing equipment, have encountered difficulty in gaining drunk driving convictions because no national standards have been developed to assure the accuracy, reliability and specificity of the tests.

LESL program manager Bob Mills is working closely with Peter Pella and Barry Diamondstone of the NBS Analytical Chemistry Division to develop performance standards for devices important to effective policing of the drunk driver, including:

- Evidential breath testers—used to obtain courtroom evidence.
- Screening breath testers—small, portable units carried by law enforcement officials for roadside tests of suspected drunk drivers.
- Breath-test calibrating units—designed to provide samples of a known alcohol concentration for calibrating breath testers.
- Remote breath collectors—used to collect breath samples for later analysis in the laboratory.
- Passive breath testers — employed to collect a breath sample from in front of a suspect's face without the need for his cooperation.

Real Vs. Ideal

Breath testing is one of the most widely used techniques because the ideal method—direct measurement of alcohol concentrations in human brain tissues—can only be performed in postmortem examinations. The breath-testing devices can be double-checked for accuracy by running laboratory comparisons with results from venous or capillary blood analysis. The output indication of most breath testers is given in units of blood alcohol concentration.

The level of blood alcohol content at which a suspect is presumed to be legally drunk in most states is .10 gram of alcohol per 100 milliliters of blood. That level is reached by a 160-pound person who has consumed seven 1-ounce drinks of 86-proof whiskey within 2 hours after eating.

Screening breath testers help policemen detect drunk drivers quickly.

Consensus Sought

Now in various stages of completion, the draft voluntary standards are first tested in an NBS laboratory and then given a thorough review by manufacturers, law enforcement officials and other experts in the field.

Performance rather than design is the keynote. Performance standards express requirements in terms of "how well," not "how" the equipshould work—leaving the door open for innovation and progress. Designers and manufacturers of new or improved instruments are not frozen out by narrow design or material requirements.

Deterrent

With a variety of ingenious breath-testing devices currently being manufactured by leading firms and more being developed, the formulation of reliable, generally accepted performance standards attesting the devices' validity is a major advance. Widely publicized, the very existence of the devices may make some drinkers hesitate before taking "one for the road." □

IRRADIATED FOODS

SAFE AT HOME?

Large-scale spoilage of food during shipment and storage is a major world problem. The National Bureau of Standards is contributing technical assistance in the area of food preservation by ionizing radiation, a method that could help alleviate future food shortages.

The inset tag, attached to sacks of potatoes at a Hungarian market, indicate that the potatoes were "ray treated" (sugarkeyelt).

EVEN in the United States, where highly sophisticated methods are used to preserve food, high costs and periodic shortages are due partly to expensive or inadequate preservation processes. Grains may still become infested with vermin, most meats and dairy products require constant refrigeration and fresh vegetables and fruits retain their marketability for an insufficient time, resulting in waste and high prices.

Although the Bureau does not itself participate in food irradiation, scientists at the Bureau's Center for Radiation Research are collaborating with other laboratories, such as the U.S. Army Natick Laboratory, to see if irradiation with x rays, gamma rays, or electron beams might be part of the answer to prolonging the storage life of some foods. For instance, it has been shown that the shelf life of many staples (cereals, meat, vegetables, fruit, dairy products and powdered eggs) can be extended by irradiation, preventing losses due to spoilage and parasites.

Irradiation is a process by which a substance is subjected to radiant energy. In the case of potentially useful food irradiation, radiation sources are limited to those supplying high-intensity photons (x and gamma rays) or electrons of a spectral energy ranging from about 1 to 10 million electron volts. Radiation absorbed doses (i.e., the amount of radiant energy absorbed per unit mass) for food preservation are from 10 thousand to several million rads (where 100 rads = 1 joule of energy absorbed per kilogram of material). The lower doses in this range can deactivate enzymes and retard sprouting or ripening, destroy certain spoilage flora and kill insect populations. The higher doses can even eliminate radiation-resistant strains of highly toxic microorganisms, such as clostridium botulinum, that might grow in unirradiated food supplies.

Thus, irradiation can extend the shelf life of many foods. In fact, meat that has been carefully packaged and sterilized by high radiation doses does not have to be refrigerated. If the radiation doses are kept at an optimum level and the treatment is carefully synergized with other treatments, such as blanching and prefreezing, the taste of the food is not adversely affected, nor are the aroma, color, or texture.

The question still unanswered is how wholesome and safe is irradiated food? Although some countries have permitted irradiated food on the market place (potatoes irradiated to delay sprouting, for example, are sold in countries such as Hungary and Poland), the general public tends to associate "radiation" with "radioactivity." The radiation that is used for food preservation, however, does not produce radioisotopes because it is kept below certain energy levels corresponding to thresholds for inducing radioactivity in materials.

It has been suggested that radiation energy absorbed by particular foodstuffs might ultimately produce chemical changes in the food itself that would be harmful to the consumer. Proponents of food irradiation respond that, although chemical and biological changes may occur in irradiated food or microorganisms, animal feeding studies so far have shown no indication that subsequent consumption of the food by animals or human beings has a detrimental effect on them or their descendants. However, the burden of positive proof of safety to the public has been placed by regulatory agencies (such as the Food and Drug Administration) upon other Government groups, scientists and industries that have proposed the acceptance of food preservation by this method.

The Delaney Clause of the 1958 Food, Drug and Cosmetic Act has made the Nation cautious about the acceptance of food containing un-

turn page

Irradiated *continued*

tested additives. The Delaney Clause states in effect that no substance can be added to food if it is found to cause cancer in any animal at any dosage. According to Food and Drug Administration regulations, radiation energy, although not a substance as such, is considered to be an "additive" and, as such, must undergo sufficient testing to be proven safe to the consumer.

At present there is a 21-country study, including the United States (represented by the U.S. Atomic Energy Commission), on irradiated foods. A report published by this International Project in the Field of Food Irradiation (based in West Germany) has indicated so far that the irradiation of food is commercially feasible. Although the cost of preserving food varies, cryogenic preservation can cost as much as 25 cents per kilogram, while low but sufficient doses of irradiation to preserve some foods could cost as little as 10 cents per *1,000* kilograms. However, it will be 1975 at the earliest before the study will indicate if food is still wholesome and safe for human consumption after irradiation. In the meantime, scientists at NBS and other laboratories will continue their efforts to add to the knowledge of useful radiation applications in agriculture, biology and commerce.

The staff of the Center for Radiation Research provides theoretical calculations and other data needed by the laboratories participating in the studies of food irradiation as well as maintaining an active interest in industrial radiation processing in general.

NBS has devised new calorimetric techniques for calibrating or measuring the response of different types of beam monitors and dosimeters to high-intensity radiations. Other project areas at NBS include the development and improvement of techniques in the calibration of sensors in continued or pulsed radiation beams, and the response of various thin-film, plastic and liquid-chemical dosimeters as a function of radiation parameters such as spectrum, dose rate and temperature. Bureau work has also led to the exploration of several new dosimeter systems being used in the radiation processing industries.

The NBS Center for Radiation Research is represented on national and international administrative bodies concerned with all types radiation processing applications including food. The Department of Commerce, which administers the U.S. Interdepartmental Committee on Preservation of Food, is joined by other U.S. Government agencies in the monitoring and evaluation of domestic and international progress in achieving worthwhile and safe food production and preservation by means of radiation application. □

COMPUTER PROGRAM FOR METRIC CONVERSION

THE National Bureau of Standards is planning to make available to American industry a computer program package to assist manufacturing companies in metric conversion. The package is based on a computer program that converts metric units on engineering drawings to their U.S. customary equivalents.

The program is suitable for use on a wide range of computers with little or no modification. The package will consist of the program itself, test problems and documentation sufficient to get the program running and to use it.

The program was developed by the Caterpillar Tractor Company and was given to NBS for distribution. Caterpillar has adopted a policy of producing all new drawings for new products in metric units and uses the program to compute and print a table converting metric units to U.S. Customary units for the specific numerical quantities appearing on a drawing. The table is reproduced on the drawing itself.

Even when a company produces a new product to metric dimensions, there are still occasions when customary dimensions are required. Caterpillar uses the converted values largely for administrative purposes—i.e., stock control, production planning, tooling selection and so on. Either set of values shown on the drawing may be used to produce satisfactory parts. Caterpillar intends to manufacture parts in their plant to the metric units using metric gages. A supplier, however, could elect to continue manufacturing in U.S. Customary units by using the conversion chart data.

The program is now in its third version. Caterpillar uses it routinely on the computer at its Technical Center in Mossville, Illinois, with access through six remote terminals located in their engineering design areas. Currently the program is used to process approximately 250 drawings per month but has a much greater capability. The program has already been made available to a number of other manufacturing companies, particularly in Caterpillar's field.

The program will be validated by NBS and distributed for a fee which will cover validation, production of copies and other expenses incurred by the government. It is anticipated that the package will be available for distribution early this year and that it will cost in the neighborhood of $500. □

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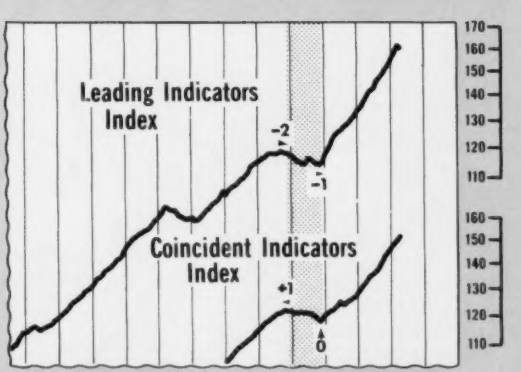

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